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Effects of message frames and visual cues on cell-cultured meat communication: sensation seeking as a moderator

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Abstract   Cell-cultured meat presents environmental and ethical advantages; however, negative public acceptance remains a significant hurdle. To generate more effective public engagement on this topic, we conducted two online experiments exploring the impact of message framing and food cues (Experiment 1) and the moderating role of an individual's personality trait, sensation seeking, (Experiment 2) on the perception of cultured meat news shared via social media. Our findings revealed that messages employing individual benefit-framing, as opposed to societal benefit-framing, resulted in more positive perceptions of cultured meat. Incorporating direct food cues in the communication led to reduced risk perception, a more favorable attitude, and increased intention to purchase cultured meat. Furthermore, sensation seeking was shown to be a significant moderator for the effects of the message features. Theoretical and practical contributions are discussed.

Introduction   Cell-cultured meat is a novel meat product derived from animal cells without the need for slaughtering animals, offering a different approach to conventional meat production methods. While the potential benefits of cell-cultured meat are recognized, the public's perception and willingness to consume it are still evolving. Given that cultured meat is relatively new and has not penetrated the commercial market, it can be assumed that a significant portion of the population has yet to engage in discussions about it. This study delves into how different communication strategies can potentially influence the public's attitudes and acceptance of cell-cultured meat, aiming not just to enhance willingness to buy but to foster a more nuanced public discourse that reflect the interactive and iterative nature of science communication.

This study investigates the role of message framing [Entman, 1993], which seeks to influence audience perception and decision-making about an issue by highlighting specific pieces of information while omitting others [Druckman & Bolsen, 2011; Scheufele & Tewksbury, 2007]. It specifically looks at the relationships between message framing, public perceptions towards cell-cultured meat and intentions to purchase. Furthermore, investigations of the impact of food cues accompanying cell-cultured meat communications are crucial, as they can help make the subject matter more accessible and enhance audience understanding. The food cues can be direct, featuring explicit depictions of food in images, or indirect, referring to images or visuals that share perceptual properties with food but do not directly depict it [Bailey, 2017]. We hypothesize that direct food cues in cell-cultured meat communication will be more effective and then also examine any significant interaction effects between message framing and food cues.

Lastly, acceptance of novel foods like cell-cultured meat is significantly influenced by audience characteristics, including individual preferences, values, and personality traits [Siegrist & Hartmann, 2020; Tuorila & Hartmann, 2020]. One such audience characteristic is sensation seeking, which reflects a person's desire for new and intense experiences. Those who score high in sensation seeking are often more adventurous in their choices, including their willingness to try unconventional foods. This openness could make them more amenable to considering cell-cultured meat as a viable dietary option. Conversely, food neophobia, or the reluctance to eat novel foods [Alley & Potter, 2011], tends to be lower in those with high sensation seeking scores [Pliner & Melo, 1997]. This audience characteristic is crucial to understand as it might help to predict how different population segments respond to novel food choices, such as cell-cultured meat. In this study, we delve into how a particular individual personality trait, sensation seeking, may influence an individual's reception to cell-cultured meat and how this trait might also interact with the way information about this new food technology is presented. By examining the role of sensation seeking, we aim to improve understanding of audience characteristics, including unique preferences and values that can subsequently inform more effective engagement strategies.

In sum, this study aims to contribute to the field of science communication by providing insights into how various message elements, including message framing and food cues, and an individual's personality trait, i.e., sensation seeking, can be orchestrated to support an informed and dynamic public dialogue about cell-cultured meat. Ultimately, the goal of the study is to move beyond a one-directional model of communication, advocating for a more interactive approach that empowers members of the public to critically engage with and shape the public narratives around emerging food technologies. By doing so, the research is expected to enhance the public's role in science communication, facilitating a collaborative exploration of the social, ethical, and environmental dimensions of cell-cultured meat.

Literature review

Cell-cultured meat and audience perceptions

Over recent decades, there has been a growing awareness of the environmental and ethical impacts associated with meat production and consumption [Wilks & Phillips, 2017]. Concerns have particularly centered around greenhouse gas

emissions, land and water use, and the welfare of farm livestock in intensive farming operations [Bryant & Barnett, 2020]. In response, there has been a surge in developing plant-based meats as a sustainable alternative to traditional livestock meat production [Van Loo, Caputo & Lusk, 2020]. Concurrently, a number of start-ups are exploring the production of cell-cultured meat, a method that involves creating meat tissues from animal cells, offering a product identical to conventional meat [Chriki & Hocquette, 2020]. Also known as in vitro, synthetic, or clean meat, cell-cultured meat is derived from animal cells obtained from a living animal and grown in controlled environments, using a nutrient serum to stimulate growth [Mancini & Antonioli, 2019]. This method is anticipated to be more resource-efficient than animal farming, requiring less land and water while emitting 80% to 95% fewer greenhouse gases globally [Goodwin & Shoulders, 2013]. Moreover, it presents an ethical advantage by eliminating the need to slaughter animals.

Despite these potential benefits, public perceptions and acceptance of cell-cultured meat remain significant challenges [Van Loo et al., 2020]. Research indicates a reluctance among a considerable portion of consumers in the United States and Australia to regularly choose cultured meat over farm-raised meat [Bogueva & Marinova, 2020; Wilks & Phillips, 2017]. For instance, only about one-third of American respondents in a recent survey expressed a willingness to regularly consume cell-cultured meat [Wilks & Phillips, 2017], and a similar hesitancy has been observed among Generation Z consumers in Australia, despite recognizing its sustainability [Bogueva & Marinova, 2020].

Both addressing these perceptual challenges and ensuring that technologies develop in line with informed consumer preferences require focusing on interactive science communication about cell-cultured meat. This is exemplified by historical cases like the BSE (Bovine Spongiform Encephalopathy) crisis and genetically modified (GM), which underscore the importance of transparent, consistent, and engaging communication strategies for fostering public trust in agricultural technology [Landrum, Hilgard, Lull, Akin & Hall Jamieson, 2018; Nunes Vaz, Dewes, Domingos Padula & Talamini, 2013]. Similarly, for cell-cultured meat, an effective communication strategy should extend beyond mere information dissemination, embracing a more dynamic interaction with the public. This approach should not only focus on facilitating a dialogue that acknowledges public concerns and presents relevant information in an interactive and balanced way [Landrum et al., 2018; Longnecker, 2016], but also on harnessing public engagement as a vital tool for guiding research and development. By actively soliciting and incorporating informed public preferences, this dialogue can ensure that the evolution of cell-cultured meat technology is attuned to consumer needs.

This approach involves addressing the potential benefits of cell-cultured meat, disseminating research findings about the introduction of such technology, and seeking engaging communication that deliver the information clearly and relatable [Knight, 2006]. Importantly, this bidirectional communication model allows for a continuous feedback loop, where public input directly informs ongoing research and development, aligning technological advancements with societal expectations and preferences. Since cell-cultured meat has not yet entered the commercial market and remains largely unknown to the public, there's a pronounced need for open and interactive communication to enhance public understanding of novel

food products. Transparent discussion about the health, safety, and characteristics of cell-cultured meat is expected to help the public form informed opinions and perceptions [Bryant & Barnett, 2020].

Effects of message framing in cultured meat news

When communicating the features and aspects of cultured meat as a novel product to general audiences, science communicators can contemplate various ways to frame those benefits. This consideration of diverse framing strategies allows for a nuanced approach that respects the audience's ability to engage with and interpret the information. By presenting cultured meat through different frames, communicators can facilitate a more inclusive and productive debate. This debate is essential for understanding public perceptions of cultured meat, especially since the technology is new and public attitudes are still forming.

While the influence of framing on consumer adoption and attitudes towards food products is well-documented [Detenber, Ho, Ong & Lim, 2018; Pjesivac, Hayslett & Binford, 2020; Van Assema, Martens, Ruiter & Brug, 2001], the exploration of effective framing strategies for cultured meat is understudied. Framing, as a communication strategy, involves highlighting certain aspects of a topic to shape audience perception and understanding [Entman, 1993]. Within this context, Chong and Druckman [2007] identified two types of framing: equivalence framing, which presents logically equivalent in different ways, and emphasis framing, which highlights different aspects of the same issue through varied messages [Chong & Druckman, 2007]. This study uses emphasis framing to examine how different presentations of cultured meat information can influence public perception and acceptance. Emphasis frames can be used to convey the potential benefits of cultured meat adoption, focusing on either societal benefit (i.e., benefit to others) or individual benefit (i.e., benefit to self). While altruism has been identified as an effective motivator for pro-social behavior, recent research has reported inconsistent findings regarding the efficacy of altruism and the potential role of self-interest in promoting such actions [Bolderdijk, Steg, Geller, Lehman & Postmes, 2013]. For example, Bolderdijk and colleagues [2013] found that participants reported a more positive effect when they read an appeal focused on the biosphere ("Want to protect the environment? Check your car's tire pressure!") than an appeal focused on economic benefits ("Want to save money? Check your car's tire pressure!"). Specifically, the effect was more pronounced when the biospheric appeal had direct implications for their positive self-concept. However, recent research has uncovered inconsistent findings regarding the efficacy of altruism and highlighted the potential role of self-interest in increasing pro-environmental behavior [Griskevicius, Tybur & Van den Bergh, 2010]. In a study investigating motivations for a consumption-curtailment (minimalist) lifestyle, Herziger and colleagues [Herziger, Berkessel & Steinnes, 2020] discovered that biospheric appeals were neither more nor less successful in inducing consumption reduction for people classified as biospheric or egoistic.

In recent years, the impact of message framing on the public's understanding of and attitude toward cultured meat products has emerged as an important area of study [Bryant & Dillard, 2019]. In general, this line of research implies that the use of cultured meat products may be seen as a more personal health issue than other

environmental activities such as recycling, environmental activism, and transportation behaviors. For instance, Siegrist, Sütterlin and Hartmann [2018] found that more technical descriptions of cultured meat products resulted in decreased acceptance compared with less technical ones. Furthermore, technical explanations and names that evoke science and unnaturalness are less appealing than names that emphasize the product's advantages over conventional meat [Siegrist & Hartmann, 2020]. Further, limited research exists on the impact of message frames on audience responses when communicating cell-cultured meat information. For example, one study comparing the impact of frames on acceptance of cultured meat found that participants who read cultured meat through the "high tech" frame, compared with "societal benefits" and "same meat" frames, had significantly more negative attitudes toward the product and were less likely to consume it [Bryant & Dillard, 2019]. However, the study found no significant differences between societal benefits and the same meat frames.

Given the gap in research regarding the effects of message framing on public understanding and attitudes towards cultured meat, this study aims to explore the effect of societal benefit (e.g., environmental impact, animal welfare) and individual benefit (e.g., product attributes or improved nutritional content) frames. To this end, we propose the following research questions:

Research Questions 1 a–d (RQ1a–d). How does the message frame (framed on societal benefit vs. individual benefit) affect (a) positive affect, (b) negative affect, (c) perceived risk, (d) attitude toward cultured meat?

Food cues as interactive message element

The appearance of food affects our perception of its taste [Delwiche, 2012], because factors such as color intensity, form, and texture all influence how we process information about food products [Bailey, 2015]. This is particularly true for meat products. Consumers are regularly confronted with visual portrayals of meat, whether through the depictions of meat-related processes or simple images of meat on packaging. These visuals act as informational "cues", shaping consumers' cognitive responses and future decision-making. Food cues can vary. They can range from explicit depictions to more subtle associations, with some cues having no direct relationship to food at all. For example, the word *food* itself can serve as a food cue, despite not representing any specific elements of a food item.

Food cues can be classified into two types: direct and indirect. Direct food cues feature explicit depictions of food, such as images of a meal, dish, or specific ingredients. These can evoke sensory experiences, memories, and emotions that influence our attitudes and desire to consume them. For instance, a photograph of a juicy steak engages the viewer's recognition and processing of the color, texture, and other characteristics of the beef. Conversely, indirect food cues use visuals or images that share some characteristics with food but don't directly represent it [Bailey, 2017]. These indirect cues can encompass elements like packaging design, color, texture, and spatial relationships that trigger associations with specific foods or food experiences. Indirect food cues may also include words or phrases related to a food product or its characteristics, forming mental connections without directly displaying the food. In the context of meat, indirect food cues might not

show the meat itself but use colors, textures, or patterns that reflect the experience of eating beef, like warm earthy tones or sizzling grill images. The packaging might also display other food-related images, such as a pastoral scene, suggesting the contents without directly revealing them. Through these direct and indirect cues, our perception and decision-making about food are continuously influenced.

Limited research exists on how variations in food cues can impact viewers' processing of food and their subsequent food consumption choices [Bailey, 2017]. Among the few studies conducted, Bailey [2015] found that direct food cues in food advertising led to overall more favorable attitudes towards both the product and the brand after exposure. In the experiment, participants were shown video food ads containing either indirect (packaged) or direct (ready-to-eat, unpackaged) food cues and were asked to rate their willingness to eat the advertised product, their attitude towards the ad, brand, and product, as well as their purchase intention. Participants rated the products with direct food cues as more desirable to eat and evaluated the ads and products more favorably, reporting a higher likelihood of purchase. A subsequent study by Bailey and Muldrow [2019] examined how other common packaging elements, such as food claims (e.g., "great taste" vs. "low fat"), influenced the effects of food directness. The results showed that direct food cues were perceived as more credible and healthier, especially when accompanied by taste-related claims for both healthier and less healthy foods. Overall, the line of studies suggest that direct food cues generally enhance perceived credibility of food products, and attitudes towards and purchasing intentions for the food products. It is likely that direct food cues offer more realistic representations of food, making them more motivating stimuli to process or encode than indirect food cues.

While perceiving food-related information, audiences tend to view any technological applications negatively. Similarly, there is a general preference for naturalness in food, characterized by minimal human intervention during production [Siegrist et al., 2018]. This preference stems from the common perception that highly processed foods are less desirable and a natural wariness towards unknown or novel food technologies [Siegrist & Hartmann, 2020]. In light of these findings, when communicating about cultured meat which is often unfamiliar and perceived as highly unnatural, it is essential to address these perceptions directly and informatively. Cell-cultured meat, biologically identical to conventional meat, is developed through scientific processes involving the cultivation of animal cells. It is important to articulate that while the production method is technologically advanced, the product closely resembles conventional meat in texture, flavor, and nutritional value. Indirect food cues are likely to keep the audience perception to cultured meat unchanged, that is, new and unnatural. When the depiction of cultured meat in meat product labels is more direct, which visually aligns with conventional meat, audiences may perceive it to be more credible as a food product, thus, a lower perceived risk, compared to indirect depiction of cultured meat. If individuals perceive cell-cultured meat as less risky, they may be more likely to engage in productive discussions regarding the direction of its development and a greater willingness to try it once it is one the market. Based on these observations, we pose the following hypotheses.

Hypothesis 1 (H1): Perceived risk to cultured meat will be lower with a direct food cue than with an indirect food cue.

Hypothesis 2 (H2): Attitude toward cultured meat will be more favorable with a direct food cue than with an indirect food cue.

Hypothesis 3 (H3): Purchase intention to cultured meat will be higher with a direct food cue than with an indirect food cue.

Interaction between message framing and food cues

Another interest of this research was to investigate the interaction between message frames and food cues within the news report. In line with the abovementioned findings, consumers prefer certain meat-specific sensory properties when they think of meat alternatives, regardless of frame types. However, when a direct food cue is combined with an individual benefit frame, with both emphasizing the same meat attributes and taste as conventional meat, audiences may find the message more appealing as congruent information increases. On the other hand, when audiences are exposed to societal benefits messages that emphasize altruistic behavior, they may prefer to see product images with less meat-like sensory properties (i.e., indirect food cues) because their information processing centers on altruistic motivation instead of egoistic ones. Hence, we hypothesize that the directness of food cues may have a different impact contingent on the context of the message (i.e., message frame). Given there has been no prior research that examined the interaction effects between message frames and food cues, we ask the following research questions:

Research Questions 2 (RQ2): How do the effects of message frames vary by the food cues to affect outcome measures of interest?

Personality trait and food consumption: sensation seeking as a moderator

Individuals have unique preferences and values that often explain the varying levels of acceptance towards food innovations. Prior research has primarily concentrated on the effects of disgust sensitivity [Lull & Scheufele, 2017], neophobia toward food technology [Alley & Potter, 2011; Bryant & Barnett, 2020], and cultural values on personality traits in accepting new food types [Siegrist & Hartmann, 2020]. Generally, familiarity with technology plays a significant role in acceptance, while food neophobia frequently leads to distrust and concern due to uncertainty [Faccio & Guiotto Nai Fovino, 2019]. As a result, cell-cultured meat, being a new technological advancement, often stirs skepticism and apprehension due to its novelty [Faccio & Guiotto Nai Fovino, 2019].

One way individuals manage their arousal levels is by choosing to approach or avoid stimuli based on their novelty, surprise value, complexity, or ability to induce uncertainty [Berlyne, 1960]. Understanding this management of arousal levels is crucial for examining decision-making in food consumption. Specifically, arousal levels can significantly influence an individual's willingness to try new foods [Pliner & Melo, 1997], such as cell-cultured meat. The optimal level of arousal theory posits that people at or above their ideal arousal level prefer less novel, complex, and uncertain stimuli than those below this level. This theory is relevant to our study as it could help explain different responses to new food technologies,

like cell-cultured meat, based on individual arousal preferences. To assess individuals' arousal levels, Zuckerman's sensation seeking, defined as a person's willingness to take risks in order to seek out novel or intense stimuli, scale is typically employed [Zuckerman, Kolin, Price & Zoob, 1964; Zuckerman, Eysenck & Eysenck, 1978].

Zuckerman's approach to individual differences indicates that high sensation seekers who enjoy complex, risky, and novel experiences are more open to trying new foods than low sensation seekers [Zuckerman et al., 1978, p. 19]. This is further supported by findings that food neophobia, or the fear of new foods, tends to be lower in those with higher excitement-seeking traits [Knaapila et al., 2007]. Moreover, high sensation seekers are more prone to engage in discussions about scientific topics [Hwang & Southwell, 2007].

Given the significant influence of the sensation-seeking personality trait on food choice and acceptance of new technologies, our study also investigates how an individual's personality trait, sensation seeking, interacts with message features in shaping audience perceptions of cell-cultured meat. This leads to the following research question:

Research Question 3 (RQ3): How do individual characteristics of sensation seeking affect the way individuals process cell-cultured meat news?

Method

The purpose of this study was twofold: (a) to understand how specific message features (e.g., message frames, food cues) would influence audiences' information processing (RQ1a–d, H1-H3, RQ2) and (b) to examine how an individual difference, specifically sensation seeking, could moderate the effects of message features (RQ3). The effects of message features were investigated in Experiment 1; the role of personality traits (sensation seeking) was investigated in Experiment 2.

Experimental stimuli and procedure

The experimental stimuli used in both experiments were designed to resemble real-life Facebook posts consisting of text and an image. These fictitious posts highlighted either societal or individual benefits associated with cultured meat. Participants were presented with four different topics: environmental benefits, animal welfare, personal health, and the nutritional and textural characteristics of cultured meat. These topics were chosen through a message sampling approach to ensure the findings could be generalized to various contexts.

Each post consisted of a headline and two text paragraphs. The first paragraph introduced findings from a study that reported the advantages of consuming cell-cultured meat, while the second paragraph provided specific details on these benefits and explained the biotechnological production process involved. The posts were attributed to *Daily Science*, a fictitious news platform created by the researcher. Other message attributes, such as the number of "likes" and user comments, were kept consistent across all conditions. For examples of the experimental stimuli, see Table 1 and for the Facebook mock-up, see Figure 1.

Table 1. Examples of core message manipulations.

	Message frames	
	Societal benefit	Individual benefit
Headline	Cell-cultured meat could contribute to environmental conservation	Cell-cultured meat could offer enhanced nutrition
Research findings	Research suggests that the environmental impacts of cell-cultured meat would be significantly less than those of conventional meat production. Studies have shown that producing cultured chicken could use up to 67 percent less land than conventional chicken farming, while cultured beef could decrease greenhouse gas emissions by up to 87 percent. Cell-cultured meat could substantially reduce the environmental footprint of meat production when compared to traditional animal farming.	Research suggests that cell-cultured meat, offering personalized nutrient profiles, may prove healthier than conventional livestock meat. It tackles primary agricultural health hazards like foodborne illnesses and antibiotic resistance. This approach helps alleviate issues related to livestock meat, such as antibiotic resistance, disease outbreaks, and the connection to heart disease and type 2 diabetes, providing consumers with a potentially enhanced meat product.
Benefits of cultured meat	Cell-cultured meat, which is meat produced in vitro using tissue engineering techniques, is being developed as a potentially more efficient and environment-friendly alternative to conventional meat. The production of animals for food has been one of the primary causes of air and water pollution and climate change. Also, with the rapidly increasing demand for meat, there is a considerable doubt that the traditional industry will be able to keep pace. This is pushing many entrepreneurs and researchers toward the development of cell-cultured meat as a viable alternative.	Cell-cultured meat, also known as in vitro meat, is produced by cultivating livestock muscle cells in a lab. Strict monitoring can help prevent meat culture infections from the outset. Moreover, any potential infection can be detected before the meat is shipped to consumers. Cell-cultured meat is not a product of genetic engineering; rather, it is meat grown from the same cells that produce meat in an animal, but in this case, the process occurs outside the animal. This technique may potentially improve several health aspects linked to conventional meat.

	Food cues	
	Direct cue	Indirect cue

Data for this study were collected using the web-based survey platform Qualtrics, and informed consent was approved by the university's institutional review board. Upon providing consent, participants were randomly assigned to one of four stimuli conditions. In each condition, they were presented with four messages: two emphasizing societal benefits and two emphasizing individual benefits. Within each frame, one message featured a direct food cue, while the other featured an indirect food cue. The order in which participants viewed the four messages was fully randomized. After reading each message, they responded to the dependent
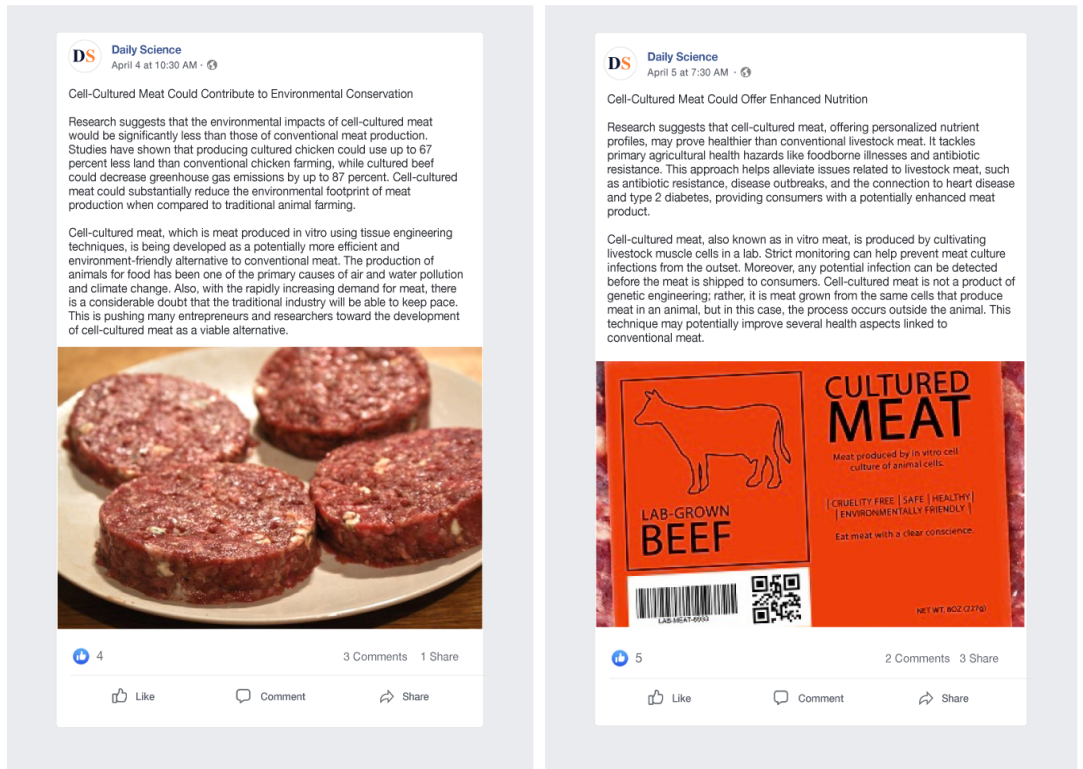
Figure 1. Left: Facebook Experimental stimuli example of societal benefit-framed message with direct visual food cue; right: individual benefit-framed message with indirect visual food cue.

variables and, finally, answered demographic questions. The entire procedure took approximately 25 minutes.

Experiment 1

Experimental design

The experiment was a 2 (message frame: societal benefits vs. individual benefits) × 2 (food cue: direct vs. indirect) factorial design online experiment. Food cue and message frame were within-subject factors and were completely crossed, creating four different message conditions: societal benefit-focused message with a direct cue; societal benefit-focused message with an indirect afood cue; individual benefit-focused message with a direct food cue; individual benefit-focused message with an indirect food cue.

Study participants

A total of 189 undergraduate students ($M_{age} = 20.50$, $SD_{age} = 3.03$, 76.2% women, 22.8% men, 1.1% other; 80.4% White, 8.5% Black; 6.3% Asian, 4.8% other) at a large midwestern university participated in the experiment in exchange for extra course credits. Most participants reported their eating habits as meat-eating (73.5%), with 11.1% consuming white meat only and 7.4% vegetarian, 3.7% pescatarian, 2.1% vegan, and 2.1% other.

Independent variables

Message frame

The message frame referred to the type of benefit information emphasized in the message, with two types of message frames: societal benefit and individual benefit. Societal benefit social media posts highlighted the potential societal advantages of consuming cell-cultured meat, such as environmental benefits and improved animal welfare. Individual benefit posts focused on potential advantages for individual consumers, like enhanced nutrition and similarity to conventional meat. Two Facebook posts emphasized societal benefits (environment and animal welfare), while the other two emphasized individual benefits (health and similarity to meat).

A message frame manipulation check was performed by using two 7-point bipolar items in which participants indicated what they believed the social media post emphasized (1 = *personal health concerns*, 7 = *environmental concerns*; 1 = *nutritional value*, 7 = *environmental value*). The scores from the two items were averaged to form a composite scale for the message frames manipulation check. The results showed a significant difference between societal benefit-framed ($M = 5.66$, SD = .96) and individual benefit-framed messages ($M = 2.90$, SD = 1.12), $t(188) = 23.64$, $p < .001$.

Food cue

Food cue was defined as visuals that supplement textual information with two levels: indirect and direct. Indirect food cues included food-associated representations like packaging, while direct food cues involved realistic visual representations of the food, such as photographs. For example, a direct food cue photo displayed four meat patties on a plate, showcasing the meat's texture and color, whereas an indirect food cue photo featured a meat package with a label stating, "Cultured Meat" and an outline of a cow. Two Facebook posts featured direct food cue photographs, whereas the other two displayed indirect food cue photographs. The study did not perform a manipulation check for the message source since it is an intrinsic message feature independent of the recipient's perceptions or responses, in line with O'Keefe [O'Keefe, 2003].

Dependent variables

Table 2 shows all the items for these measures. The scores were averaged to form a composite dependent variable index.

Perceived risk of cell-cultured meat

Perceived risk of cell-cultured meat was measured by two items adapted from prior research [Dixon, 2016]. Across the conditions, reliability (Cronbach's α) ranged from .87 to .97.

<p style="text-align:center;">**Table 2**. Measures with associated items.</p>

Measures	Items
Perceived risks of cell-cultured meat (1 = strongly disagree, 7 = strongly agree)	1. The likelihood of experiencing severe side effects by eating cell-cultured meat is high 2. The likelihood that the cell-cultured meat negatively affects a person's body is high
Positive affect toward the message (1 = not at all, 7 = extremely)	While viewing the social media post, I felt: 1. Optimistic 2. Enthusiastic
Negative affect toward the message (1 = not at all, 7 = extremely)	While viewing the social media post, I felt: 1. Worried 2. Concerned
Perceived message effectiveness	1. Not Convincing — Convincing 2. Not believable — Believable 3. Not sensible — Sensible 4. Foolish — Wise 5. Wrong — Right
Attitude toward cell-cultured meat	1. Bad — Good 2. Unlikeable — Likable
Purchase intention (1 = definitely no, 7 = definitely yes)	1. How willing are you to try cultured meat? 2. How willing are you to buy cultured meat regularly? 3. How willing are you to eat cultured meat as a replacement for conventionally produced meat?
Sensation seeking (1 = strongly disagree, 7 = strongly agree)	1. I would like to explore strange places 2. I would like to take off on a trip with no pre-planned routes or timetables 3. I get restless when I spent too much time at home 4. I prefer friends who are excitingly unpredictable 5. I like to do frightening things 6. I would like to try bungee jumping 7. I like wild parties 8. I would like to have new and exciting experiences, even if they are illegal

Positive affect toward the message

Positive affect toward the message was measured by two items adapted from prior research [Cooper & Nisbet, 2016]. Across the conditions, reliability (Cronbach's α) ranged from .85 to .96.

Negative affect toward the message

Negative affect toward the message was measured by two items adapted from prior research [Balls-Berry et al., 2016; Cooper & Nisbet, 2016]. Across the conditions, reliability (Cronbach's α) ranged from .85 to .92.

Attitude toward cell-cultured meat

Attitude toward the cell-cultured meat was measured by two items adapted and modified from a previous study [Lee, Lee & Dockter, 2021]. Across the conditions, reliability (Cronbach's α) ranged from .90 to .97.

Purchase intention

Intention to purchase cultured meat was measured by four items adapted from previous research [Bryant & Dillard, 2019]. Across the conditions, reliability (Cronbach's α) ranged from .88 to .95.

Results

A 2 within (frame: societal benefits vs. individual benefits) × 2 within (food cue: direct vs. indirect) subjects repeated measures analysis of variance (ANOVA) was performed on each dependent variable. Follow-up pairwise comparisons were adjusted using least significant difference. All analyses were conducted using SPSS 28 General Linear Models.

Impact of message frames

RQ1a–d asked how message frames would affect (a) positive affect, (b) negative affect, (c) perceived risk, and (d) attitude toward cultured meat. There was a significant main effect of message frame on positive affect, $F(1, 187) = 6.90$, $p = .009$, $\eta^2 = .04$, on negative affect, $F(1, 187) = 23.73$, $p < .001$, $\eta^2 = .13$, on perceived risk, $F(1, 187) = 38.08$, $p < .001$, $\eta^2 = .17$. Individual benefit-framed news (vs. societal benefit-framed news) resulted in more positive affect to the news story ($M_{\text{Individual}} = 4.01$, $SE_{\text{Individual}} = .11$; $M_{\text{Societal}} = 3.88$, $SE_{\text{Societal}} = .11$), lower negative affect to the news story ($M_{\text{Individual}} = 2.32$, $SE_{\text{Individual}} = .09$; $M_{\text{Societal}} = 2.75$, $SE_{\text{Societal}} = .09$), and lower perceived risks ($M_{\text{Individual}} = 2.96$, $SE_{\text{Individual}} = .07$; $M_{\text{Societal}} = 3.27$, $SE_{\text{Societal}} = .08$). However, there was not a statistically significant main effect of message frame on attitude toward cultured meat, $F(1, 187) = 2.78$, $p = .097$, $\eta^2 = .02$.

Impact of food cues

H1-3 predicted that the message with a direct food cue would exhibit a lower perceived risk (**H1**), a more favorable attitude (**H2**), and higher purchase intention (**H3**) towards cultured meat, compared to the message with an indirect food cue. There was a significant main effect of food cue on risk perception, $F(1, 187) = 9.13$, $p = .003$, $\eta^2 = .05$, on attitude, $F(1, 187) = 3.76$, $p = .054$, $\eta^2 = .02$, and on purchase intention, $F(1, 187) = 4.17$, $p = .043$, $\eta^2 = .02$. News story with a direct food cue (vs. indirect food cue) results in a lower risk perception ($M_{\text{Direct}} = 3.03$, $SE_{\text{Direct}} = .08$; $M_{\text{Indirect}} = 3.19$, $SE_{\text{Indirect}} = .08$), a more favorable attitude ($M_{\text{Direct}} = 5.09$, $SE_{\text{Direct}} = .09$; $M_{\text{Indirect}} = 4.99$, $SE_{\text{Indirect}} = .09$), and a higher purchase intention ($M_{\text{Direct}} = 3.83$, $SE_{\text{Direct}} = .12$; $M_{\text{Indirect}} = 3.74$, $SE_{\text{Indirect}} = .12$). Therefore, hypotheses 1–3 were supported.

Interaction effects between message frames and food cues

RQ2 asked how the effects of message frames varied by the food cues to affect **outcome measures of interests**. There was a significant two-way interaction effect between message frames and food cues on positive affect, $F(1, 187) = 7.14$, $p = .049$, $\eta^2 = .02$. Pairwise comparison showed that participants reported more
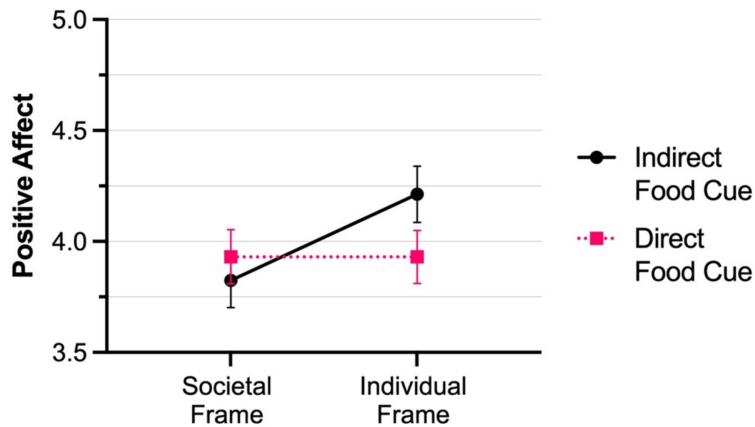
Figure 2. A two-way interaction effect between food cues and news frames on positive affect. *Note*. The scale on the y-axis is 3.5–5.0 (instead of the full range of 1–7) because the interaction effect was too small to visualize on the full range scale.

positive affect when they read news presented with an individual benefit-framed message with an indirect food cue ($M = 4.21$, SE $= .13$) than a direct one ($M = 3.93$, SE $= .12$), $p = .020$. However, the differences were not statistically significant when participants read news with societal benefit-framed news with a direct food cue ($M = 3.93$, SD $= 1.67$) or with an indirect food cue ($M = 3.82$, SD $= 0.12$), $p = .379$. See Figure 2.

The two-way interaction effect between message frames and food cues was not significant on other outcome measures of interest: on negative affect, $F(1, 187) = .55$, $p = .459$, $\eta^2 = .00$; perceived risk perception, $F(1, 187) = .03$, $p = .874$, $\eta^2 = .00$; attitude toward cultured meat, $F(1, 187) = 1.33$, $p = .251$, $\eta^2 = .01$.

Experiment 2

Experimental design

In Experiment 2, we sought to apply and extend findings from Experiment 1 by adding sensation seeking as an individual difference variable. It was an online experiment with a 2 within (frame: societal benefits vs. individual benefits) × 2 within (food cue: direct vs. indirect) × 2 between (sensation seeking: high vs. low) mixed-factorial design.

Study participants

A total of 143 undergraduate students ($M_{age} = 20.46$, SD$_{age} = 3.26$, 75.5% women, 23.1% men, 1.4% other; 82.5% White, 7.0% Black; 7.0% Asian, 3.5% other) completed the experiment. Most participants reported their eating habits as meat-eating (75.5%), with 7.7% eating white meat only and 7.7% vegetarian, 3.5% pescatarian, 2.8% vegan, and 2.8% other.

Independent variables

Two independent variables and all dependent variables in Experiment 2 were consistent with those in Experiment 1.

Sensation seeking

In assessing sensation seeking, the Sensation Seeking Scale Form V (SSS-V) by Zuckerman et al. [1978] is commonly used. However, this 40-item, dichotomous-choice format scale has been criticized due to concerns about its reliability, length, use of colloquial language, and the forced-choice nature of its responses [Hoyle, Stephenson, Palmgreen, Lorch & Donohew, 2002; Stephenson, Hoyle, Palmgreen & Slater, 2003]. Addressing these concerns, we opted for Hoyle et al.'s [2002] Brief Sensation Seeking Scale (BSSS). This eight-item scale retains Zuckerman's conceptualization but in a more concise format, aligning with our study's need for an efficient and reliable measure of sensation seeking. Table 2 shows all the items for this measure. The scores from the eight items were averaged to form a composite scale for sensation seeking (Cronbach's $\alpha = .78$). The median split was taken to create high- ($N = 69$, $M = 5.44$, SD $= .61$) and low- ($N = 74$, $M = 3.70$, SD $= .66$) sensation seeking groups.

Results

Overall, the results of message manipulations (i.e., message frames and food cues) in Experiment 2 were in line with the results from Experiment 1. The summary of repeated measures ANOVAs for experiment 2 is presented in Table 3.

Table 3. The summary of repeated measures ANOVAs of Experiment 2.

Predictors	*Outcome measures*											
	Perceived risk			Attitude			Purchase intention					
Food cue (Direct vs. Indirect)	F	p	η^2	F	p	η^2	F	p	η^2			
	5.46	.021	.04	4.17	.043	.03	4.95	.028	.03			
	Positive Affect			Negative Affect			Perceived risk			Attitude		
Frame (Societal vs. Individual)	F	p	η^2	F	p	η^2	F	p	η^2	F	p	η^2
	8.96	.003	.06	22.12	$< .001$	.14	24.55	$< .001$	.15	2.25	.136	.02
	Positive Affect			Negative Affect			Perceived risk			Attitude		
Food cue X Frame (Interaction)	F	p	η^2	F	p	η^2	F	p	η^2	F	p	η^2
	7.49	.007	.05	.104	.748	.001	.025	.874	.00	.090	.764	.001

Sensation seeking as a moderator

RQ3 asked how sensation seeking would moderate the message effects. There were statistically significant two-way interaction effects between food cue and sensation seeking on attitude toward cultured meat, $F(1, 141) = 8.75$, $p = .004$, $\eta^2 = .06$ and on purchase intention, $F(1, 141) = 5.71$, $p = .018$, $\eta^2 = .04$. Pairwise comparison showed that low sensation seeking participants reported more favorable attitudes toward cultured meat when they read news presented with the direct food cue ($M = 4.82$, SE $= .13$) rather than an indirect one ($M = 4.57$, SE $= .14$), $p = .05$. However, the differences between direct ($M = 5.15$, SE $= .14$) and indirect ($M = 5.04$, SE $= .14$) food cues were not statistically significant among high sensation seeking participants, $p = .234$. Pairwise comparison showed that low sensation seeking participants reported more willingness to purchase cultured meat when they read news presenting a direct food cue ($M = 3.57$, SE $= .20$) than an indirect one ($M = 3.31$, SE $= .20$), $p = .001$. However, the differences between
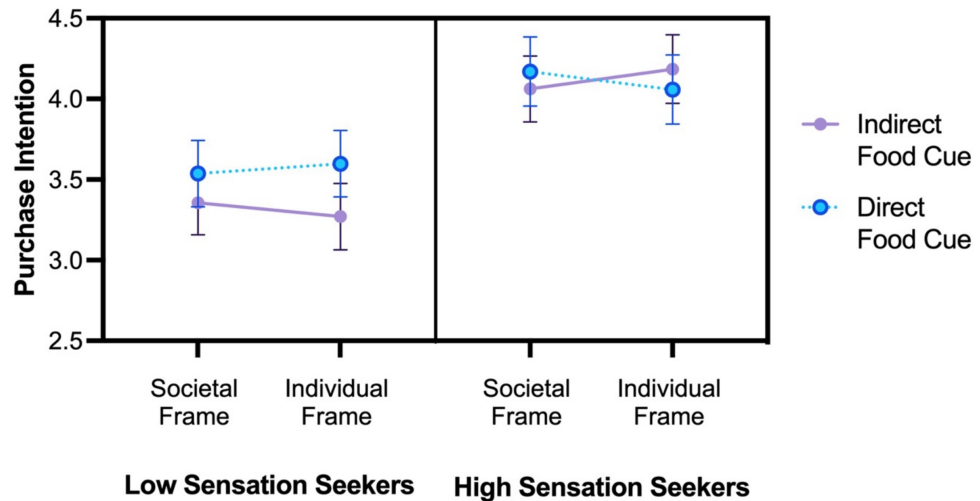
Figure 3. A three-way interaction effect between food cues, news frames, and sensation seeking on purchase intention. *Note*. The scale on the y-axis is 2.5–4.5 (instead of the full range of 1–7) because the interaction effect was too small to visualize on the full range scale.

direct ($M = 4.11$, SE $= .20$) and indirect ($M = 4.12$, SE $= .20$) food cues were not statistically significant among high sensation seeking participants, $p = .909$.

Last, the analysis yielded a significant three-way interaction among food cues, frames, and sensation seeking on purchase intention, $F(1, 141) = 3.73$, $p = .05$, $\eta^2 = .03$. Pairwise comparison showed that when low sensation-seeking participants showed a higher willingness to purchase cultured meat when they read the individual-framed-news with a direct food cue ($M_{\text{Individual-Direct}} = 3.60$, $SE_{\text{Individual-Direct}} = .21$), compared with an indirect food cue ($M_{\text{Individual-Indirect}} = 3.27$, $SE_{\text{Individual-Indirect}} = .21$). The differences were not significant when they read societal benefit news, or among participants with high sensation seeking. See Figure 3.

Discussion

This study investigated the effects of message framing and visual food cues on attitudinal, behavioral outcomes, and perceived risks toward cultured meat news on social media, with the aim of promoting greater informed public discussion of cell-cultured meat. Furthermore, another goal was to see how participants' tendency to seek high levels of stimulation — sensation seeking — would moderate the effects of message frames and visual food cues, given that individuals process information differently depending on their personality traits.

We investigated the effects of message frames by comparing messages emphasizing societal benefits with those focusing on individual benefits of consuming cultured meat. Contrary to the belief that altruism drives pro-environmental behavior [Bolderdijk et al., 2013; Dietz, 2015], our results indicate that news emphasizing individual benefits led to more positive feelings than news highlighting societal benefits. This may be because people prioritize personal health and view health risks as more important than societal benefits like environmental conservation or animal welfare. Also, societal benefits, such as environmental conservation or animal welfare, may be perceived as more

psychologically distant compared to immediate individual benefits like taste and personal health. As a result, people might find it harder to relate to these distant benefits, reducing the impact of messages focusing on societal gains. In addition, emphasizing individual benefits may give people a sense of control over their own well-being and the impact of their choices. This feeling of control could make them more receptive to messages focusing on personal benefits, as opposed to societal benefits, which might seem beyond their immediate influence.

Our findings indicate that visual depictions of food that are realistic and natural, such as photographs, can be linked to more favorable attitudes toward food products and could potentially enhance the willingness to purchase them.
It appears that direct food cues of cell-cultured meat led to a higher overall acceptance of the product compared to indirect food cues. A direct depiction resembling conventional meat may reduce consumers' perception of risk associated with cell-cultured meat, linked to the inherent uncertainty of its origin. Moreover, the general preference for familiar stimuli [de Vries, Holland, Chenier, Starr & Winkielman, 2010] suggests that direct food cues, such as photographs of cultured meat resembling conventional meat, could help the product appear more familiar, potentially leading to increased acceptance and willingness to purchase. Furthermore, such direct food cues may diminish the perceived novelty of the product, making it seem more approachable for consumers, which in turn could help alleviate concerns that impeded critical dialogue. Considering this, science communicators may find it beneficial to employ clear and engaging images or descriptions of cultured meat, as part of a comprehensive communication strategy that seeks to involve the audience in a meaningful exploration of this innovative technology.

There was a significant interaction effect between message frames and food cues on positive affect, such that when the news report was framed in terms of individual benefits, displaying an indirect visual cue (e.g., packaged meat product with labels and illustration of meat), it resulted in a more positive response than a direct visual cue. This suggests that the combination of food cues and message frames may provide supplementary information that enhances information processing. When discussing individual benefits, such as taste and texture, people might respond more positively to indirect food cues because they feel less discomfort associated with the consumption of cell-cultured meat. Direct food cues, like realistic photos of the meat, present the audience with certainty about cell-cultured meat or might evoke feelings of guilt toward conventional meat, especially among those who are concerned about the ethical implications of consuming conventional meat.

To further investigate the effects of message features, we looked at sensation seeking as an individual difference variable influencing the audience's information processing of the cultured meat news report. Low sensation seekers responded more positively to direct food cues, favoring familiarity with conventional meat products. Low sensation seekers may prefer clearer, more familiar information, be more comfortable with familiar options, and be less concerned with social trends, opting for traditional products. Also, our results suggest that when low sensation seekers read news about cultured meat that was framed around individual benefits and featured explicit depictions or descriptions of the meat, they were more willing to consider purchasing the product. This finding underscores the significance of tailoring communication strategies to effectively inform diverse audiences about

cultured meat, especially those who may be less inclined towards novelty and risk-taking. These insights suggest the importance of integrating clear, fact-based information into educational programs about cultured meat. Such programs could emphasize understanding individual benefits and utilize engaging visual aids to enhance comprehension and interest.

Implications and limitations

Recent content analysis studies have examined public discourse around cultured meat in both social media and traditional media. Specht, Rumble and Buck [2020] analyzed social media conversations, revealing a landscape marked by diverse and varied opinions. This lack of clear consensus highlights the complex and multifaceted nature of public perceptions and discussions around cultured meat online. On the other hand, traditional media coverage, as analyzed by Painter, Brennen and Kristiansen [2020], has portrayed cultured meat predominantly in a positive light, suggesting a more favorable reception in these outlets. Furthermore, themes on Twitter (now X) included the legality and marketing of cultured meat, sustainability, and animal concerns, which were tweeted by philanthropists, journalists, and animal welfare advocates who promoted cultured meat to save the environment. We present evidence in this study that, in contrast to current message strategies, emphasizing personal interests may be effective in motivating people to engage in pro-environmental behavior, such as cultured meat consumption. Highlighting personal benefits of cultured meat, such as taste and quality, and displaying a realistic photograph of it within the news story could be used to motivate audiences to learn more about cultured meat and its potential benefits.

In conclusion, emphasizing personal interests and incorporating food cues that appeal to different sensation seekers can enhance the public's understanding of cultured meat and its benefits. This approach not only educates the public on the science behind cultured meat but also guides practitioners in developing effective communication strategies to encourage consumers to engage productively with this issue and promote pro-environmental behavior.

While this study offers important insights into the communication strategies surrounding cultured meat, it is important to acknowledge its limitations. The research was confined to the context of cultured meat, which has direct implications for personal health and well-being. It would be beneficial for future studies in science communication to investigate if framing effects vary across a broader range of pro-environmental behaviors beyond personal health concerns. Additionally, the study's reliance on a college student population, primarily accessed through online platforms, may not fully represent the broader public's perspectives. The general population's information processing and decision-making could differ significantly, especially considering the varied information sources they utilize beyond social media. This demographic and channel specificity could influence the effectiveness of communication strategies and should be a focus for future research. Moreover, as the study anticipates consumer reactions to a product that has not yet been commercialized, it is based on hypothetical scenarios rather than real-world experience. The actual market introduction of cultured meat may reveal new factors influencing public conceptions that were not captured in this study. Therefore, subsequent research

should aim to examine public responses to cultured meat in a real-world context, considering a diverse audience and multiple information channels. This approach will provide a more comprehensive understanding of the communication strategies needed to facilitate greater public engagement with the topic of cultured meat.

Despite these limitations, the study contributes to the theoretical and practical understanding of framing effects, food cues, and their interaction in cultured meat communication. It also investigates sensation seeking as a potential individual difference variable when examining message audiences. This study highlights the importance of developing effective message strategies to mitigate perceived risks associated with cultured meat that might impede more critical and informed public debate prior to commercialization.

References

Alley, T. R. & Potter, K. A. (2011). Food neophobia and sensation seeking. In V. R. Preedy, R. R. Watson & C. R. Martin (Eds.), *Handbook of behavior, food and nutrition* (pp. 707–724). doi:10.1007/978-0-387-92271-3_47

Bailey, R. & Muldrow, A. (2019). Healthy food identification: food cues and claims affect speeded and thoughtful evaluations of food. *Health Communication 34* (7), 735–746. doi:10.1080/10410236.2018.1434734

Bailey, R. L. (2015). Processing food advertisements: initial biological responses matter. *Communication Monographs 82* (1), 163–178. doi:10.1080/03637751.2014.971417

Bailey, R. L. (2017). Influencing eating choices: biological food cues in advertising and packaging alter trajectories of decision making and behavior. *Health Communication 32* (10), 1183–1191. doi:10.1080/10410236.2016.1214222

Balls-Berry, J. E., Hayes, S., Parker, M., Halyard, M., Enders, F., Albertie, M., . . . Radecki Breitkopf, C. (2016). The effect of message framing on African American women's intention to participate in health-related research. *Journal of Health Communication 21* (5), 527–533. doi:10.1080/10810730.2015.1103333

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. doi:10.1037/11164-000

Bogueva, D. & Marinova, D. (2020). Cultured meat and Australia's Generation Z. *Frontiers in Nutrition 7*, 148. doi:10.3389/fnut.2020.00148

Bolderdijk, J. W., Steg, L., Geller, E. S., Lehman, P. K. & Postmes, T. (2013). Comparing the effectiveness of monetary versus moral motives in environmental campaigning. *Nature Climate Change 3* (4), 413–416. doi:10.1038/nclimate1767

Bryant, C. & Barnett, J. (2020). Consumer acceptance of cultured meat: an updated review (2018–2020). *Applied Sciences 10* (15), 5201. doi:10.3390/app10155201

Bryant, C. & Dillard, C. (2019). The impact of framing on acceptance of cultured meat. *Frontiers in Nutrition 6*, 103. doi:10.3389/fnut.2019.00103

Chong, D. & Druckman, J. N. (2007). Framing theory. *Annual Review of Political Science 10*, 103–126. doi:10.1146/annurev.polisci.10.072805.103054

Chriki, S. & Hocquette, J.-F. (2020). The myth of cultured meat: a review. *Frontiers in Nutrition 7*, 7. doi:10.3389/fnut.2020.00007

Cooper, K. E. & Nisbet, E. C. (2016). Green narratives: how affective responses to media messages influence risk perceptions and policy preferences about environmental hazards. *Science Communication 38* (5), 626–654. doi:10.1177/1075547016666843

de Vries, M., Holland, R. W., Chenier, T., Starr, M. J. & Winkielman, P. (2010). Happiness cools the warm glow of familiarity: psychophysiological evidence that mood modulates the familiarity-affect link. *Psychological Science 21* (3), 321–328. doi:10.1177/0956797609359878

Delwiche, J. F. (2012). You eat with your eyes first. *Physiology & Behavior 107* (4), 502–504. doi:10.1016/j.physbeh.2012.07.007

Detenber, B. H., Ho, S. S., Ong, A. H. & Lim, N. W. B. (2018). Complementary versus competitive framing effects in the context of pro-environmental attitudes and behaviors. *Science Communication 40* (2), 173–198. doi:10.1177/1075547018758075

Dietz, T. (2015). Altruism, self-interest, and energy consumption. *Proceedings of the National Academy of Sciences 112* (6), 1654–1655. doi:10.1073/pnas.1423686112

Dixon, G. N. (2016). Negative affect as a mechanism of exemplification effects: an experiment on two-sided risk argument recall and risk perception. *Communication Research 43* (6), 761–784. doi:10.1177/0093650215579222

Druckman, J. N. & Bolsen, T. (2011). Framing, motivated reasoning, and opinions about emergent technologies. *Journal of Communication 61* (4), 659–688. doi:10.1111/j.1460-2466.2011.01562.x

Entman, R. M. (1993). Framing: toward clarification of a fractured paradigm. *Journal of Communication 43* (4), 51–58. doi:10.1111/j.1460-2466.1993.tb01304.x

Faccio, E. & Guiotto Nai Fovino, L. (2019). Food neophobia or distrust of novelties? Exploring consumers' attitudes toward GMOs, insects and cultured meat. *Applied Sciences 9* (20), 4440. doi:10.3390/app9204440

Goodwin, J. N. & Shoulders, C. W. (2013). The future of meat: a qualitative analysis of cultured meat media coverage. *Meat Science 95* (3), 445–450. doi:10.1016/j.meatsci.2013.05.027

Griskevicius, V., Tybur, J. M. & Van den Bergh, B. (2010). Going green to be seen: status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology 98* (3), 392–404. doi:10.1037/a0017346

Herziger, A., Berkessel, J. B. & Steinnes, K. K. (2020). Wean off green: on the (in)effectiveness of biospheric appeals for consumption curtailment. *Journal of Environmental Psychology 69*, 101415. doi:10.1016/j.jenvp.2020.101415

Hoyle, R. H., Stephenson, M. T., Palmgreen, P., Lorch, E. P. & Donohew, R. L. (2002). Reliability and validity of a brief measure of sensation seeking. *Personality and Individual Differences 32* (3), 401–414. doi:10.1016/s0191-8869(01)00032-0

Hwang, Y. & Southwell, B. G. (2007). Can a personality trait predict talk about science?: Sensation seeking as a science communication targeting variable. *Science Communication 29* (2), 198–216. doi:10.1177/1075547007308599

Knaapila, A., Tuorila, H., Silventoinen, K., Keskitalo, K., Kallela, M., Wessman, M., . . . Perola, M. (2007). Food neophobia shows heritable variation in humans. *Physiology & Behavior 91* (5), 573–578. doi:10.1016/j.physbeh.2007.03.019

Knight, D. (2006). *Public understanding of science: a history of communicating scientific ideas*. doi:10.4324/9780203966426

Landrum, A. R., Hilgard, J., Lull, R. B., Akin, H. & Hall Jamieson, K. (2018). Open and transparent research practices and public perceptions of the trustworthiness of agricultural biotechnology organizations. *JCOM 17* (02), A04. doi:10.22323/2.17020204

Lee, S., Lee, N. & Dockter, C. E. (2021). Effects of message presentation type on GM food risk perception, similarity judgment, and attitude. *Health Communication 36* (13), 1666–1676. doi:10.1080/10410236.2020.1787926

Longnecker, N. (2016). An integrated model of science communication — more than providing evidence. *JCOM 15* (05), Y01. doi:10.22323/2.15050401

Lull, R. B. & Scheufele, D. A. (2017). Understanding and overcoming fear of the unnatural in discussion of GMOs. In K. Hall Jamieson, D. M. Kahan & D. A. Scheufele (Eds.), *The Oxford handbook of the science of science communication*. doi:10.1093/oxfordhb/9780190497620.013.44

Mancini, M. C. & Antonioli, F. (2019). Exploring consumers' attitude towards cultured meat in Italy. *Meat Science 150*, 101–110. doi:10.1016/j.meatsci.2018.12.014

Nunes Vaz, F., Dewes, H., Domingos Padula, A. & Talamini, E. (2013). Meat market reaction towards mass media and science communication on Bovine Spongiform Encephalopathy. *JCOM 12* (02), A02. doi:10.22323/2.12020202

O'Keefe, D. J. (2003). Message properties, mediating states, and manipulation checks: claims, evidence, and data analysis in experimental persuasive message effects research. *Communication Theory 13* (3), 251–274. doi:10.1111/j.1468-2885.2003.tb00292.x

Painter, J., Brennen, J. S. & Kristiansen, S. (2020). The coverage of cultured meat in the US and UK traditional media, 2013–2019: drivers, sources, and competing narratives. *Climatic Change 162* (4), 2379–2396. doi:10.1007/s10584-020-02813-3

Pjesivac, I., Hayslett, M. A. & Binford, M. T. (2020). To eat or not to eat: framing of GMOs in American media and its effects on attitudes and behaviors. *Science Communication 42* (6), 747–775. doi:10.1177/1075547020947743

Pliner, P. & Melo, N. (1997). Food neophobia in humans: effects of manipulated arousal and individual differences in sensation seeking. *Physiology & Behavior 61* (2), 331–335. doi:10.1016/s0031-9384(96)00406-4

Scheufele, D. A. & Tewksbury, D. (2007). Framing, agenda setting, and priming: the evolution of three media effects models. *Journal of Communication 57* (1), 9–20. doi:10.1111/j.0021-9916.2007.00326.x

Siegrist, M. & Hartmann, C. (2020). Consumer acceptance of novel food technologies. *Nature Food 1* (6), 343–350. doi:10.1038/s43016-020-0094-x

Siegrist, M., Sütterlin, B. & Hartmann, C. (2018). Perceived naturalness and evoked disgust influence acceptance of cultured meat. *Meat Science 139*, 213–219. doi:10.1016/j.meatsci.2018.02.007

Specht, A. R., Rumble, J. N. & Buck, E. B. (2020). "You call that meat?" Investigating social media conversations and influencers surrounding cultured meat. *Journal of Applied Communications 104* (1), 3. doi:10.4148/1051-0834.2303

Stephenson, M. T., Hoyle, R. H., Palmgreen, P. & Slater, M. D. (2003). Brief measures of sensation seeking for screening and large-scale surveys. *Drug and Alcohol Dependence 72* (3), 279–286. doi:10.1016/j.drugalcdep.2003.08.003

Tuorila, H. & Hartmann, C. (2020). Consumer responses to novel and unfamiliar foods. *Current Opinion in Food Science 33*, 1–8. doi:10.1016/j.cofs.2019.09.004

Van Assema, P., Martens, M., Ruiter, R. A. C. & Brug, J. (2001). Framing of nutrition education messages in persuading consumers of the advantages of a healthy diet. *Journal of Human Nutrition and Dietetics 14* (6), 435–442. doi:10.1046/j.1365-277x.2001.00315.x

Van Loo, E. J., Caputo, V. & Lusk, J. L. (2020). Consumer preferences for farm-raised meat, lab-grown meat, and plant-based meat alternatives: does information or brand matter? *Food Policy 95*, 101931. doi:10.1016/j.foodpol.2020.101931

Wilks, M. & Phillips, C. J. C. (2017). Attitudes to *in vitro* meat: a survey of potential consumers in the United States. *PLoS ONE 12* (2), e0171904. doi:10.1371/journal.pone.0171904

Zuckerman, M., Eysenck, S. B. & Eysenck, H. J. (1978). Sensation seeking in England and America: cross-cultural, age, and sex comparisons. *Journal of Consulting and Clinical Psychology 46* (1), 139–149. doi:10.1037/0022-006x.46.1.139

Zuckerman, M., Kolin, E. A., Price, L. & Zoob, I. (1964). Development of a sensation-seeking scale. *Journal of Consulting Psychology 28* (6), 477–482. doi:10.1037/h0040995

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